Customer Spotlight: Bruker AFMs Help Boise State Researchers Reach New Nanoscale Limits

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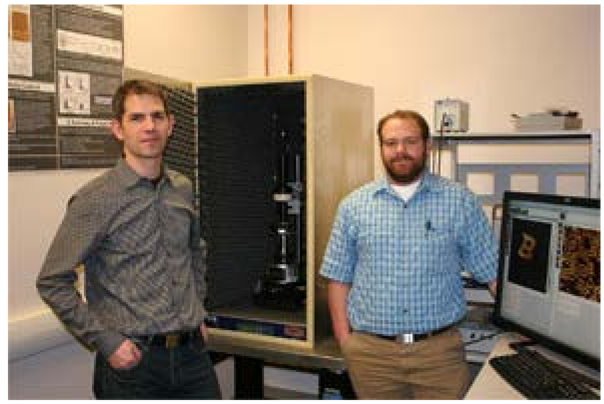
The project at Boise State was led by Dr. Elton Graugnard, who is an assistant professor in the Department of Materials Science and Engineering (MSE). The Boise State "B" DNA origami project was conceived to help students learn how to produce DNA origami nanostructures.



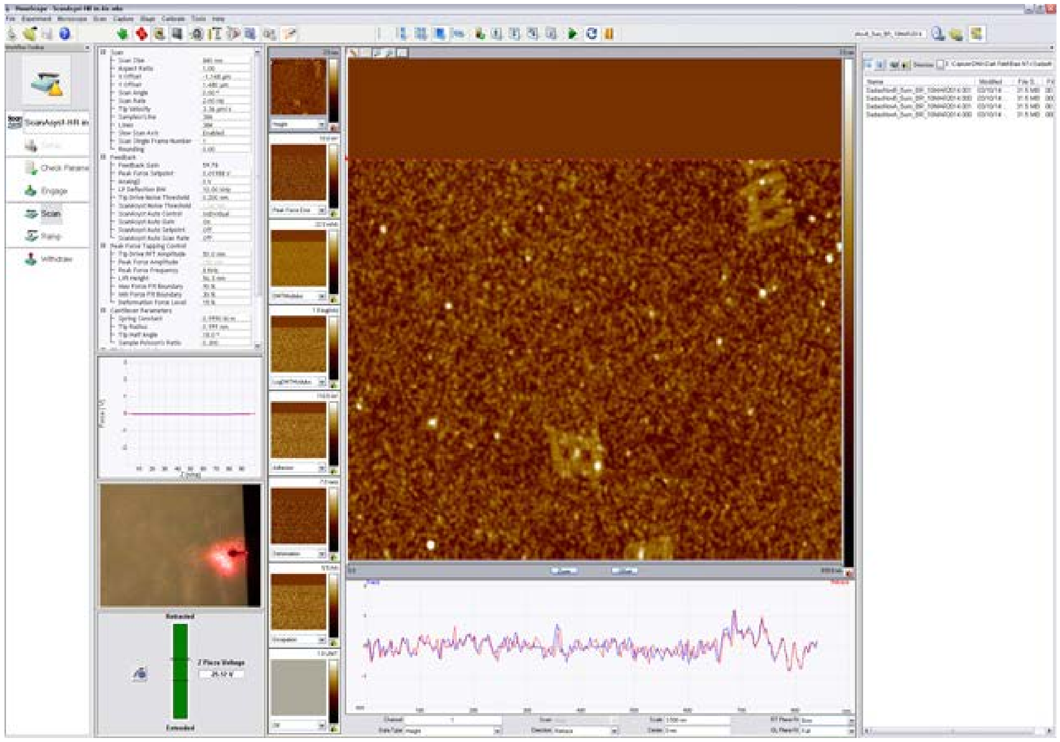
Dr. Graugnard (left) and PhD student Brett Ward working on the DNA Origami project in the Boise State lab with the Bruker MultiMode 8.
Photo by Paul H. Davis.

"The students need something to get started with, so we thought this would be a fun way for them to learn," said Graugnard. "The logo synthesis was really a training exercise in this technique of DNA origami. You use DNA as a programmable sort of breadboard for organizing nanoparticles at a scale that is difficult to achieve with other techniques. If you can make something that looks like a "B" it demonstrates that you can make arbitrary shapes."

The Boise State researchers used a technique known as "DNA origami," invented by Paul Rothemund, senior research fellow at the California Institute of Technology (Caltech). Computer-aided design (CAD) software, developed by Shawn Douglas (at UCSF), called caDNAno that is specifically for DNA origami was used to lay out the shape. "Once you establish what you think is a viable design, then you purchase the DNA from a company that makes synthetic DNA, and from another company you purchase the scaffold strand, which is harvested from a bacteriophage," Graugnard explained. The DNA strands were mixed in solution, and about one trillion identical Bs made from synthetic DNA were produced in about four hours.

And how did they know that this worked? Research validation requires some form of microscopy, and Graugnard said his group relies heavily on AFM. "For this project we've used both the MultiMode 8, which took the image we have in the Boise State newsfeed, and we also used the Dimension Icon," he said. "For both, the low noise floor is important for being able to see the origami, which is 2 nanometers in height when they're on a mica surface, and only about 80 nanometers wide for this design."

The project researchers took advantage of Bruker's PeakForce Tapping mode on the MultiMode 8. "If you're going to be able to resolve the little holes inside the "Bs" you need a sharp probe and a low noise floor," Graugnard emphasized.



Formation of Boise "B" DNA displayed on screen of the MultiMode 8. Photo by Kelly Schutt.

The MultiMode 8 is equally well suited for imaging in both air and fluid, but the research team did fluid imaging with the MultiMode 8 to be able to see the individual helices in the origami. Similar DNA structures are being developed in Boise State's Nanoscale Materials and Device Group as novel materials for building future electronic and optical computer circuits from molecules.

So what's next for the Boise researchers? Graugnard said they're trying to use DNA origami to pattern semiconductor surfaces for future memory devices and that they have a research program in collaboration with Harvard University and Micron Technology, which is headquartered in Boise and makes flash memory.

"Flash memory tends to be at the leading edge of the size for semiconductor devices, explains Graugnard. "All of that is at the limit of what can be done with photolithography, so people are looking at how to extend technologies to make smaller and smaller patterns. We've got a way to build patterns from the molecular scale up, and the idea is to then merge with larger patterns that are made with photolithography. So the fine scale would be controlled by the origami shapes rather than by a photo pattern."

Dr. Elton Graugnard
Photo courtesy Boise State University.

Dr. Elton Graugnard

Dr. Elton Graugnard's research interests are atomic layer deposition (ALD), scanning probe microscopy, and DNA-based nanotechnology, which he pursues as a member of the Nanoscale Materials and Device Group. Prior to joining Boise State, Graugnard taught physics at Rollins College and involved students in photonic crystals and atomic layer deposition (ALD) research.

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